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BRIEF COMMUNICATION: Effect of twinning and sex on carcass weight and composition in lambs

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INTRODUCTION

Lamb producers are being provided with strong incentives to gain better control over the growth performance of their animals. These incentives are driven by increased demand for lean product of consistent quality, rigid market specifications, and significant penalties when carcasses do not meet the criteria imposed by processors. Feed conversion efficiency is enhanced when the ratio of lean to fat deposition is improved (Sillence, 2004). This is an important consideration for producers due to rising costs of generating high quality feed. Hence, increasing the proportion of carcasses that meet market specifications can improve the profitability of a lamb-production enterprise.

Over the last decade, sheep producers have substantially improved production performance by increasing prolificacy and exploiting breed and genotype variability in carcass composition (Afolayan *et al.,* 2007; Ponnampalam, *et al.,* 2008; Young & Amer, 2009) by adopting genetic selection strategies to increase meat production performance. Twins account for up to 85% of all sheep pregnancies but have lower birth and weaning weights compared to singles even in well-fed ewes (McCoard *et al*., 2001; Kenyon *et al.,* 2008). This is a key constraint for lamb finishing systems.

The effects of sex and birth rank on carcass composition under New Zealand conditions between 1963 and 1978 have been reported previously (e.g. Bennett *et al.,* 1991). To our knowledge, the effects of sex and birth rank on carcass composition in lambs of modern genetics, in particular those bred for superior meat production performance, have not been reported. This brief communication reports the effects of birth rank and sex on carcass traits at slaughter in a large commercial population bred for meat production.

MATERIALS AND METHODS

Carcass trait records from 11,072 lambs across four years (2003 to 2007) were sourced from the Rissington Breedline Primera® terminal breeding programme. The dataset comprised of 2,327 singletons (1,203 female, 1,124 intact male) and 8,745 twins (4,469 female and 4,276 intact males). Lambs were weaned between 73 and 110 days (mean = 91 days), and slaughtered at an average age of 142 days with an average carcass weight of 16 kg at a commercial abattoir over two consecutive days each year.

Carcass weight and carcass fat depth at the GR site (FatGR; total tissue depth to the 12th rib, 110mm from the midline) were measured on the hot carcass with a grading ruler (mm). Carcasses were chilled at approximately 4°C for 24 h, and fat depth at the C site (FatC, depth of fat over the maximum depth of eye muscle, *M. Longissimus thoracis et lumborum*, at the 12/13th rib, Palsson (1939)), eye muscle width (carcass EMW) (Measurement A (Palsson, 1939)) and eye muscle depth (carcass EMD) (Measurement B (Palsson, 1939)) measured at the maximum width depth and depth of the muscle at the 12/13th rib, recorded. In addition, eye muscle depth and width of the French rack, hind leg weight and length, boneless loin (*M. Longissimus dorsi*), and tenderloin (*M. Psoas major*) weight were also recorded. Carcass measurements were made using a ruler (mm) and electronic scales.

The data was analysed in GenStat (Payne *et al.,* 2009) using a mixed effects model with age, birth rank, sex and interaction of birth rank and sex as fixed effects, and year of lamb birth and sire as random effects.

RESULTS AND DISCUSSION

Carcass weight

Age had a significant effect on carcass weight (P <0.001). At the same age, sex accounted for more variability in carcass weight than birth rank, however both were significant (P <0.001). Overall, twins had 10% (1.7kg) lower carcass weights, and females had 7% (~1kg) lower carcass weights compared to their single and male counterparts, respectively (Table 1). These results highlight that despite increased productivity of twins (kg lamb/ewe), birth rank and sex are key constraints on carcass weight, a key determinant of the economic value of lamb (Waldron *et al*., 1991) and thus farmer profits.

TABLE 1: Effect of birth rank and sex on carcass components at slaughter, not adjusted for carcass weight. Data presented as predicted means and standard error of differences (SED). EMD = Eye muscle depth; EMW = Eye muscle width. FatC = Depth of fat at the 12/13th rib; FatGR = Total tissue depth to the 12th rib.

Trait type	Measurement	Females		Males		SED
		Single	Twin	Single	Twin	
Carcass traits	Number of carcasses	1,203	4,469	1,124	4,276	
	Carcass weight (kg)	16.7[a]	15.0[b]	17.8[c]	16.1[d]	0.1
Muscle-related traits	Hind leg weight (kg)	2.31[a]	2.14[b]	2.37[c]	2.23[d]	0.01
	Hind leg length (mm)	312[a]	305[b]	320[c]	313[a]	1
	Boneless loin weight (g)	225[a]	207[b]	234[c]	216[d]	2
	Tenderloin weight (kg)	80.4[a]	73.5[b]	82.2[c]	75.6[d]	0.7
	Carcass EMD (mm)	27.7[a]	26.4[b]	27.3[a]	26.4[b]	0.2
	Carcass EMW (mm)	56.7[a]	55.8[b]	58.9[c]	58.0[d]	0.3
	French rack EMD (mm)	22.4[a]	21.8[b]	22.8[c]	22.2[a]	0.2
	French rack EMW (mm)	36.4[a]	36.1[b]	37.5[c]	37.1[d]	0.2
Fat-related traits	FatC	1.06[a]	0.90[b]	0.92[b]	0.78[c]	0.02
	FatGR	6.4[a]	4.9[b]	4.7[b]	3.9[a]	0.1

[a,b,c] Means in the same row with different superscript letters are significantly different (P <0.05).

TABLE 2: Effect of birth rank and sex on carcass components at slaughter, adjusted for carcass weight. Data presented as predicted means and standard error of differences (SED). EMD = Eye muscle depth; EMW = Eye muscle width. FatC = Depth of fat at the 12/13th rib; FatGR = Total tissue depth to the 12th rib.

Trait type	Measurement	Females		Males		SED
		Single	Twin	Single	Twin	
Carcass traits	Number of carcasses	1,203	4,469	1,124	4,276	
Muscle-related traits	Hind leg weight (kg)	2.20	2.20	2.20	2.20	0.01
	Hind leg length (mm)	309[a]	309[a]	313[b]	312[b]	1
	Boneless loin weight (g)	215[a]	220[b]	209[c]	214[a]	1
	Tenderloin weight (kg)	77.1[a]	77.6[a]	74.4[b]	75.0[b]	0.5
	Carcass EMD (mm)	26.9[a]	27.0[a]	25.8[b]	26.2[b]	0.2
	Carcass EMW (mm)	55.8[a]	56.4[b]	57.2[c]	57.7[d]	0.3
	French rack EMD (mm)	21.9[a]	22.3[b]	21.9[a]	22.1[a]	0.2
	French rack EMW (mm)	36.1[a]	36.4[b]	36.7[b]	37.0[bc]	0.2
Fat-related traits	FatC	1.04[a]	1.02[a]	0.80[b]	0.81[b]	0.02
	FatGR	5.9[a]	5.4[b]	3.6[c]	3.8[c]	0.1

[a,b,c] Means in the same row with different superscript letters are significantly different (P <0.05).

Carcass muscle traits

When age alone is accounted for, it had a significant effect on muscle-related traits (P <0.001). At the same age, birth rank accounted for more variability in boneless loin and tenderloin weight and carcass EMD than sex, while sex accounted for more variability in leg weight and length, carcass EMW, and French rack EMD and EMW, however, both were significant (P <0.001). For females, twins had 8% lower hind leg, boneless loin and tenderloin weight than singles, and also 5% lower carcass EMD, while other carcass traits exhibited less than 5% difference between birth ranks (Table 1). Similar birth rank effects were observed for males, and within each birth rank, sex had only minor effects on carcass traits (Table 1).

When both age and carcass weight were accounted for, they each had a significant effect on muscle-related traits (P <0.001) with carcass weight accounting for most of the variability observed (P <0.001). At a common carcass weight and age, boneless loin weight, carcass and French rack EMW (P <0.001), and French rack EMD (P <0.05) differed between birth rank groups. All muscle-related traits (P <0.001) differed between males and females, sex accounted for more variability than birth rank, but there was little evidence of a birth rank by sex interaction. Although the effect of birth rank and sex on many muscle-related carcass traits at a common carcass weight were significant, the effects were relatively minor (<5%; Table 2), as reported previously (Afaloyan *et al.,* 2007) and are unlikely to be of economic significance under the current payment system. However, the move towards a yield-based system will increase the economic importance of these small but significant differences in muscle traits between birth ranks and the sexes.

Carcass fatness

When age alone is accounted for, both FatC and FatGR differed significantly between birth rank and sex (P <0.001). At a common age, twin carcasses had 15% less fat at the C site and 24% less fat at the GR site compared to singles, and for males, the corresponding decreases were 15% and 17%, respectively (Table 1). For twins, female carcasses had 13% and 27% (13% and 20% for singles) more fat at the C and GR sites respectively compared to males (Table 1).

When carcass weight was also included, it had a significant effect on carcass fatness at both the C and GR sites (P <0.001). At a common carcass weight and age, sex accounted for more variability in carcass fatness than birth rank, but both were significant (P <0.001) and there was a significant birth rank by sex interaction for FatGR (P <0.001). Within each birth rank group, females were 32% and 64% (singles) and 26% and 42% (twins) fatter than their male counterparts at the C and GR sites respectively (Table 2). In contrast, between birth rank groups, single females had 9% greater carcass fatness at the GR site than twin females with no difference at the C site, and carcass fatness did not differ between single and twin male lambs (Table 2).

The magnitude of the effect of birth rank and sex on carcass fatness in the present study was greater than previously reported. For example, at the same carcass weight, female lambs have been reported to be 11% fatter at the FatC site than male lambs with no sex differences at the FatGR site (Afolayan *et al.,* 2007), whereas in this study, a 32% and 64% difference at the C and GR sites respectively was observed between males and females. It is well established that genetics and nutrition (pasture quality, quantity and type) influence carcass composition (Lee *et al.,* 1990; Hopkins *et al.,* 2007; Ponnampalam *et al.,* 2008). Hence, the differences observed between the present study and that by Afolayan *et al.* (2007) may be due to differential production systems and genetics between Australia and New Zealand. Furthermore, the lambs evaluated in the present study were younger (range of 122 to 152 days compared to 152 to 241 days) and had lower carcass weight (16 kg vs 22 kg) compared to the lambs evaluated by Afolayan *et al.* (2007), hence the effects of sex and birth rank on carcass fatness may also diminish with age.

CONCLUSION

This study supports the overall findings of previous work where male carcasses were heavier and leaner than female carcasses, that carcasses from twin lambs were smaller and leaner than carcasses from single lambs, and that the effects of sex and birth rank on muscle-related carcass traits were largely proportional to carcass weight (Makarechian *et al.,* 1978; Lee *et al.,* 1990; Bennett *et al.,* 1991; Afolayan *et al.,* 2007). These observations highlight that despite genetic selection for increased meat production, sex and birth rank remain major determinants of carcass weight and fatness in lambs under current New Zealand grazing and management systems.

As current lamb value is largely driven by carcass weight and fat content (FatGR), this study indicates that consideration could be given to the separate management and age at drafting of male and female, and twin and single lambs, in order to meet market specifications for carcass weight and fatness at slaughter. Furthermore, the differences in carcass weight and fatness between the sexes and birth ranks could be exploited by producers to supply lambs that meet different market specifications.

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